MACS –a New High Intensity Cold Neutron Spectrometer at NIST
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Inelastic neutron scattering is a unique probe of nano-scale dynamic phenomena in solids. Unfortunately, current instrumentation often limits applicability to cases where large crystalline samples can be produced. The Multi Axis Crystal Spectrometer (MACS) now under development at NIST, aims to broaden the range of materials that can be analyzed with this powerful technique. Two orders of magnitude improvement in efficiency is achieved by focusing cold neutrons with a Bragg lens and using a multiplexing detection system. Dynamic short range order is important in many topical condensed matter systems. While MACS will be a general purpose spectrometer for energies less than 20 meV, it will be particularly well suited for probing dynamic nano-scale structure. In a matter of hours the instrument will deliver a map of the wave vector dependence of inelastic neutron scattering, from which real space short range order can be extracted by Fourier inversion.

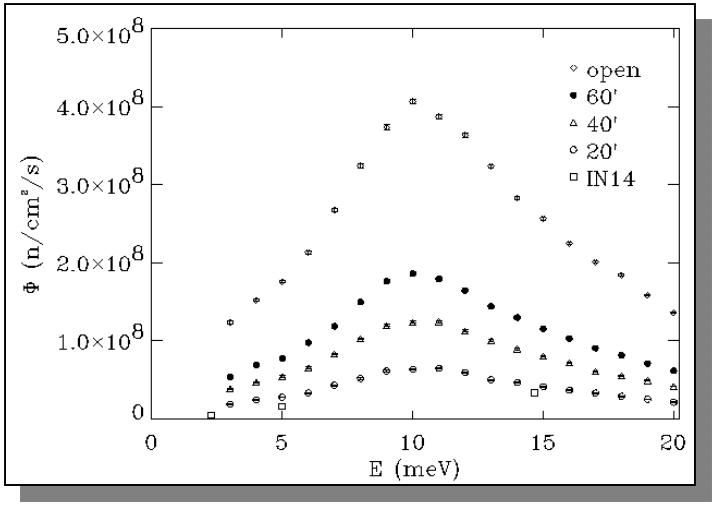

Fig. 1. Flux on sample versus energy calculated with MC Simulation. The flux will significantly exceed the current record from IN14 at the ILL in France.

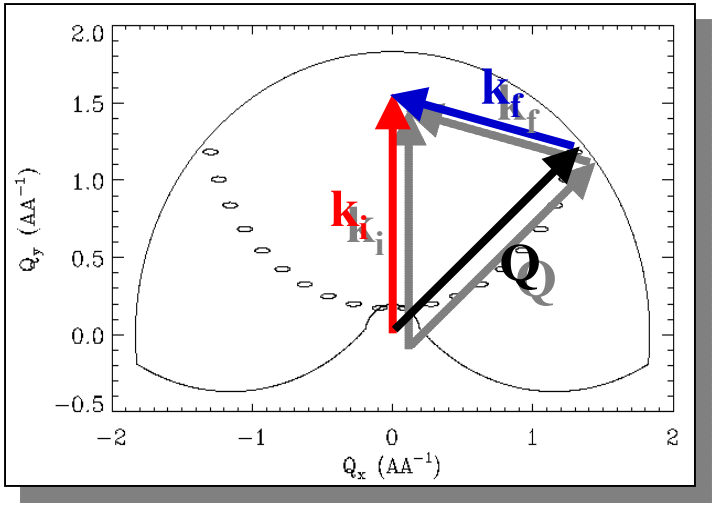

Fig. 2. Typical region of wave vector space mapped by MACS. The ellipses show the areas probed by the 21 detection channels in one setting.

How we are designing MACS
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The design work for MACS is being carried out by the MACS systems engineer Timothy Pike in consultation with Dr. Broholm representing the scientific side and NIST engineer Christoph Brocker representing the NIST engineering group. This fall, subprojects will be offered as senior projects for JHU mechanical engineering students. The students will learn to develop cutting edge science instrumentation in collaboration with a group of top class professional engineers. A graduate student, Yiming Qiu, who is moving to NIST in the fall has played a crucial role in performing Monte Carlo simulations to evaluate performance.

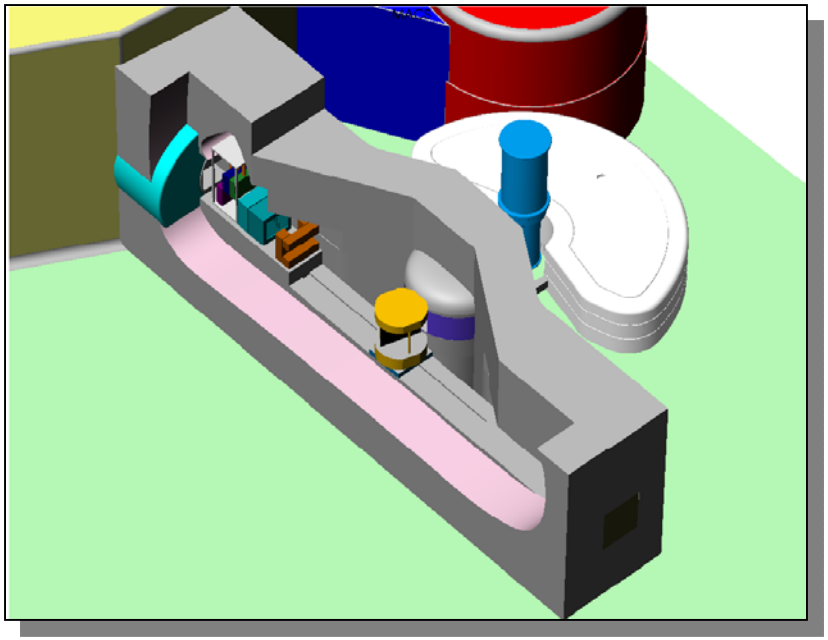

Fig. 3. Isometric view of the MACS cold neutron spectrometer. Along the beam line are seen shutter, cooled Be, PG, and Al2O3 filters, 60' and 40' radial collimators, variable aperture, monochromator, super-mirror guide, cryostat and detector system.

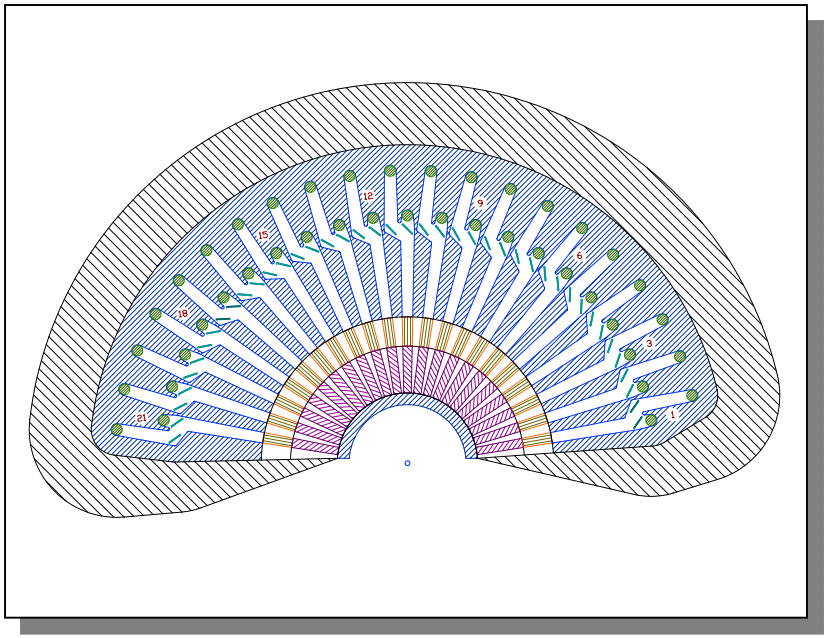

Fig. 4. Top view of the MACS 21 channel detection system. The design emphasis is high reliability and efficiency and ultra low background. Shielding thickness averages 33 cm of moderating and absorbing material.